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LISTS OF SPECIES

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Fish diversity of Tembeling and Pahang rivers, Pahang, Malaysia

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Abstract: This study aim to provide an updated checklist of fish species inhabiting Tembeling and Pahang rivers, Pahang, Malaysia. A total of 4,834 fish belonging to 10 orders, 64 genera, 25 families and 82 species were collected from both connected rivers. Cyprinidae present the highest number of fish species registered herein, followed by Bagridae, Pangasiidae and Siluridae. The most common fish species were *Cyclocheilichthys apogon*, followed by *Barbonymus schwanefeldii*, *Hypsibarbus wetmorei*, *Amblyrhynchichthys truncatus* and *Puntioplites proctozysron*. A total of nine introduced fish and four endangered fish species were also recorded from this study. This checklist adds knowledge on the fishes inhabiting both rivers, which could be useful for the planning of fisheries activities and fish conservation of the rivers in the near future.

Key words: ichthyofauna, species inventory, tropical fishes, conservation

INTRODUCTION

Pahang is the largest state in Peninsular Malaysia, measuring approximately 36,000 km². The Pahang River basin is located in the eastern part of the state, and is the longest river in Peninsular Malaysia (Tachikawa et al. 2004; Yassin et al. 2013). The river is about 440 km long, and drains an area of 29,300 km², of which 27,000 km² lies within Pahang, while 2,300 km² is located in Negeri Sembilan. The land surrounding Pahang River area are mainly characterized by 73.2% of forests, 10% of rubber plantations, 10% of lakes, rivers and marshes, 4% of oil palm plantations, and 2.8% of agricultural fields and urban areas (Tachikawa et al. 2004).

The Pahang River is divided into the Jelai and Tembeling rivers, which meet near Kuala Tembeling, Jerantut District. The Jelai River, with a length of 156 km and catchment area of 7,320 km², is 85% covered by forests. However, Tembeling River tributary, with the river length of 153 km and the catchment area of 5,050 km² is mainly covered by forests, rubber plantations, oil palm plantations, and lakes, rivers and marshes at 66%, 13%, 12%, and 9%, respectively. The river system begins to flow in the south east and south direction from the north passing along major towns such as Kuala Lipis, Jerantut, Temerloh, and finally turning eastward at Mengkarak in the central south flowing through Pekan town near the coast before discharging into the South China Sea (Tachikawa et al. 2004).

No comprehensive study on the fish diversity along the Tembeling and Pahang rivers has been conducted, but several previous studies reported their richness in ichthyofauna (Adnan 2011; Yahya and Singh 2012; Zulkafli et al. 2014a, 2014b). Indeed, both rivers provide an important habitat for protection, breeding, and aquaculture activities of several commercial fish species (Haslawati et al. 2007; Samah et al. 2013), while inhabited by numerous endangered fish species (Zulkafli et al. 2014a, 2014b). This study reports a comprehensive fish checklist of Tembeling and Pahang rivers, Pahang, Malaysia.

MATERIALS AND METHODS

This study was conducted in the Tembeling and Pahang rivers, two main rivers in Pahang, Peninsular Malaysia. Sampling was carried out in Jerantut District (Tembeling River) and in Pekan, Maran, and Temerloh districts (Pahang River) (Figure 1). Samples were taken from March 2003 to April 2005 (26 months) in Pekan District, July 2005 to July 2006 (13 months) in Maran District, October 2007 to September 2008 (12 months) in Temerloh District, and August 2006 to August 2007 (13 months) in Jerantut District. A total of one, seven, five, and eight sampling sites in each district were selected in Pekan, Maran, Temerloh and Jerantut, respectively (Table 1).

In Maran, Temerloh and Jerantut districts, drift and static gill nets (15–30 m long × 2.5–4.0 m wide), ranging from 2 to 23 cm between knots, were used at each sampling point. The gill nets were set between 7:00–10:00 h, maintained in

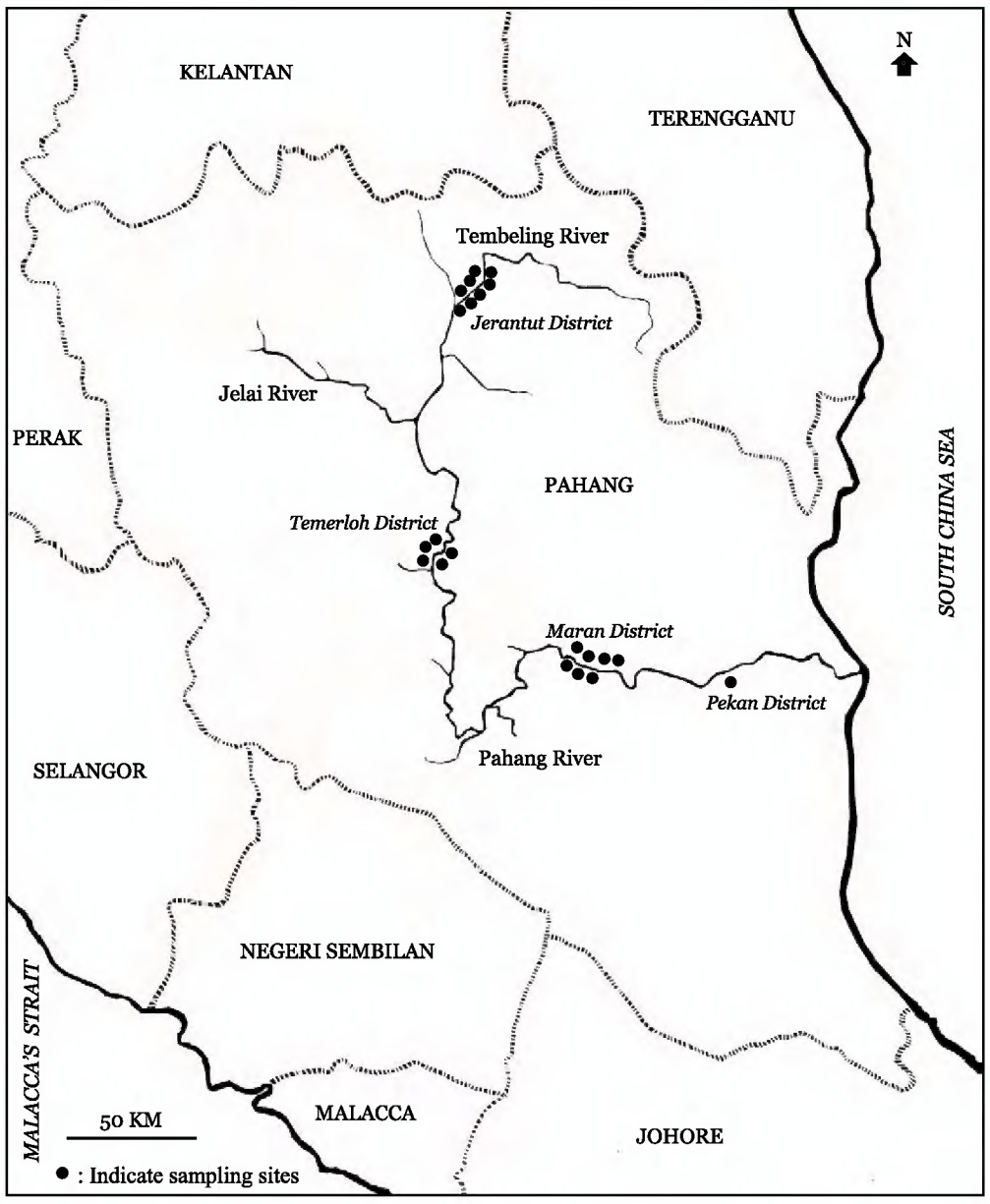

Figure 1. Location of sampling sites in Tembeling and Pahang rivers, Pahang, Peninsular Malaysia

position, checked at every 7–10 h, and hauled in after 24 h (Zulkafli et al. 2014a). Traditional fishing gears, such as cast nets and fishing rods, were also utilized. However, in Pekan District, the fish samples were collected at the local fish market from fishermen.

Those fish that could confidently be identified were enumerated, and if still alive, were released back to their natural environment. The fishes that could not be identified in the field were fixed in 10% formalin solution and later transferred to 70% ethanol solution for permanent storage in the fish collection of Freshwater Fisheries Research Center, Fisheries Research Institute, Jelebu, Negeri Sembilan. The samples were then transported back to the laboratory for further counting and taxonomic identification based on Ambak et al. (2010) and Froese and Pauly (2015). The current names of the fishes were derived from Kottelat (2013), while the threat statuses of all the collected fish were based on the IUCN Red List of threatened species (IUCN 2015).

The diversity, evenness and richness indexes in each sampling district were calculated based on Shannon and Weaver (1963), Pielou (1969) and Margalef (1958), respectively, with the exception of Pekan District due to non-random sampling of the fishes in the district.

Table 1. Coordinates of sampling sites in Tembeling and Pahang rivers, Pahang, Peninsular Malaysia.

River	District	Site	Coordinates
Pahang River	Pekan	1	03°29′23.3″ N, 103°06′11.7″ E
	Maran	1	03°29′52.7″ N, 102°46′49.0″ E
		2	03°29′58.3″ N, 102°46′35.7″ E
		3	03°29′44.5″ N, 102°46′03.5″ E
		4	03°30′08.2″ N, 102°45′05.9″ E
		5	03°30′16.3″ N, 102°43′59.9″ E
		6	03°30′41.8″ N, 102°42′55.0″ E
		7	03°30′57.5″ N, 102°41′53.1″ E
	Temerloh	1	03°45′23.3″ N, 102°23′36.2″ E
		2	03°45′41.5″ N, 102°23′13.7″ E
		3	03°45′46.9″ N, 102°22′40.6″ E
		4	03°45′37.6″ N, 102°21′59.8″ E
		5	03°45′00.0″ N, 102°22′03.8″ E
Tembeling River	Jerantut	1	04°23′54.5″ N, 102°25′48.5″ E
		2	04°24′33.4″ N, 102°26′03.4″ E
		3	04°25′07.2″ N, 102°26′08.0″ E
		4	04°25′42.5″ N, 102°26′15.0″ E
		5	04°25′52.9″ N, 102°26′11.3″ E
		6	04°25′48.8″ N, 102°27′18.6″ E
		7	04°25′54.9″ N, 102°27′44.8″ E
		8	04°27′43.5″ N, 102°28′55.2″ E

RESULTS

A total of 4,834 fish belonging to 10 orders, 64 genera, 25 families and 82 species were collected from both connected rivers. The highest total number of fish species was recorded in Maran (64 species), followed by Temerloh (55 species), Jerantut (47 species), and Pekan (28 species) districts (Table 2).

The order Cypriniformes was predominant in terms of number of species with 40 species, followed by Siluriformes with 19 species, and Perciformes with 12 species. The remaining orders showed either one, two or four species only.

Cyprinidae recorded the highest number of fish species based on family (38 species), followed by Bagridae, Pangasiidae and Siluridae (five species). The other fish families were observed to have between one to four species only.

The top five most common fish species registered were *Cyclocheilichthys apogon* (479 specimens), *Barbonymus schwanefeldii* (368 specimens), *Hypsibarbus wetmorei* (312 specimens), *Amblyrhynchichthys truncates* (266 specimens) and *Puntioplites proctozysron* (254 specimens).

A total of nine introduced fish were collected, *Barbonymus gonionotus*, *Ctenopharyngodon idella*, *Hypophthalmichthys nobilis*, *Labeo rohita*, *Oreochromis* sp., *Trichopodus pectoralis*, *Hypostomus plecostomus*, *Pangasius bocourti* and *Pangasianodon hypophthalmus*. In addition, four fish species listed by the IUCN Red List of Threatened Species as endangered were also identified, including the species of *Balantiocheilos melanopterus*, *Probarbus jullieni*, *Himantura signifer* and *P. hypophthalmus*.

For Shannon-Weaver Diversity, Pielou's Evenness, and Margalef's Richness Indexes, our study showed that all of the mean indexes during the study periods were the highest in Temerloh, followed by Maran and Jerantut districts (Table 2).

DISCUSSION

Approximately 1,000 species of freshwater fish have been documented in the Southeast Asian tropics, whereas recently, about 420 species could be found in Malaysia (Hashim et al. 2012a). Even though the total number of fish species that inhabit the Tembeling and Pahang rivers is unknown, in the nearby area, for example along the Endau River, Johore, a total of 108 fish species have been documented by Ng and Tan (1999). Similarly, in Endau Rompin State Park, Pahang-Johore, 47 fish species have been recorded by Lim et al. (1990). A fish survey conducted recently by Yahya and Singh (2012) reported a total of 17 fish species belonging to four families inhabited Keniam River, in the National Park in Pahang, where its tributaries are part of the Tembeling River drainage basin.

From our study, a total of 82 species belonging to 25 families of fish have been identified from Tembeling and Pahang rivers. This number of species was lesser compared to the study conducted in another important river in north part of Peninsular Malaysia, the Perak River, in which 107 fish species belonging to 33 families were recorded (Hashim et al. 2012a). This comparable finding was expected due to the expansion of the sampling sites in Chenderoh, Kenering, Bersia, and Temengor lakes, which are situated along the Perak River. Moreover, most of the fish were caught by gill nets, followed by cast nets and fishing rods, without utilization of electrofishing, which may increase the accuracy of the sampling techniques (Ismail et al. 2013). However, the high number of fish species in the Tembeling and Pahang rivers is good news in the context of the ichthyofauna in Malaysia.

Table 2. Fish species collected, their number and sites of capture in Tembeling and Pahang rivers, Pahang, Peninsular Malaysia.

Order / Family	Species	IUCN Status[1]	Site[2]				Voucher[3]
			P	M	T	J	
Anguilliformes							
Anguillidae	*Anguilla marmorata* Quoy & Gaimard, 1824	LC				1	UT048
Beloniformes							
Belonidae	*Xenentodon canciloides* (Bleeker, 1854)	LC		2	1		LP073
Cypriniformes							
Botiidae	*Syncrossus hymenophysa* (Bleeker, 1852)	NA		1		2	LP129
Cobitidae	*Acantopsis dialuzona* van Hasselt, 1823	LC		5			LP090
Cyprinidae	*Amblyrhynchichthys truncatus* (Bleeker, 1850)	NA		177	23	66	LP033
	Cyclocheilichthys repasson (Bleeker, 1853)	LC			16	11	NV
	Balantiocheilos melanopterus (Bleeker, 1850)	EN		25		7	LP037
	Barbichthys laevis (Valenciennes, 1842)	LC		101	18	71	UT018
	Barbodes banksi (Herre, 1940)	LC		1			LP112
	Barbodes lateristriga (Valenciennes, 1842)	LC			1		NV
	**Barbonymus gonionotus* (Bleeker, 1849)	LC		22	3		LP132
	Barbonymus schwanefeldii (Bleeker, 1854)	LC	6	150	88	130	LP055
	Cirrhinus caudimaculatus (Fowler, 1934)	LC		4	23	160	LP088
	Crossocheilus oblongus Kuhl & van Hasselt, 1823	LC		1		7	LP164
	**Ctenopharyngodon idella* (Valenciennes, 1844)	NA		12			LP087
	Cyclocheilichthys apogon (Valenciennes, 1842)	LC		207	49	223	LP057
	Cyclocheilos enoplos (Bleeker, 1849)	NA		2			LP032
	Hampala macrolepidota Kuhl & van Hasselt, 1823	LC	9	5	10	23	UT024
	**Hypophthalmichthys nobilis* (Richardson, 1845)	DD	1		1		NV
	Hypsibarbus pierrei (Sauvage, 1880)	DD		61	3	3	LP027
	Hypsibarbus wetmorei (Smith, 1931)	LC	22	244	49	19	UT025
	Labeo chrysophekadion (Bleeker, 1849)	LC			2		UT026
	**Labeo rohita* (Hamilton, 1822)	LC	1				NV
	Labiobarbus festivus (Heckel, 1843)	NA		13	57	104	LP133
	Labiobarbus leptocheilus (Valenciennes, 1842)	NA		19		5	LP028
	Leptobarbus hoevenii (Bleeker, 1851)	NA	1				NV
	Luciosoma setigerum (Valenciennes, 1842)	DD		7	12	9	LP018
	Macrochirichthys macrochirus (Valenciennes, 1844)	NT			6	5	UT001
	Mystacoleucus obtusirostris (Valenciennes, 1842)	NA		33	24	38	LP069
	Osteochilus melanopleura (Bleeker, 1852)	LC	11	24	7	3	LP041
	Osteochilus microcephalus (Valenciennes, 1842)	LC			1	10	NV
	Osteochilus spilurus (Bleeker, 1851)	LC		10		25	LP022
	Osteochilus vittatus (Valenciennes, 1842)	LC		92	23	10	LP089
	Osteochilus waandersii (Bleeker, 1853)	LC			24	2	NV
	Paralaubuca typus Bleeker, 1864	LC		25	28	12	LP020
	Probarbus jullieni Sauvage, 1880	EN	24	93	2	17	LP009
	Puntioplites bulu (Bleeker, 1851)	DD	24	43	2	18	LP053

Continued

Table 2. *Continued.*

Order / Family	Species	IUCN Status[1]	Site[2] P	M	T	J	Voucher[3]
	Puntioplites proctozysron (Bleeker, 1864)	NA				254	UT004
	Raiamas guttatus (Day, 1870)	LC		5	4	9	UT008
	Rasbora sumatrana (Bleeker, 1852)	NA		16	18	48	LP015
	Thynnichthys thynnoides (Bleeker, 1852)	LC		54	43		LP001
	Tor tambroides (Bleeker, 1854)	DD				1	NV
Myliobatiformes							
Dasyatididae	*Himantura signifer* Compagno & Roberts, 1982	EN			1		KM008
Osteoglossiformes							
Notopteridae	*Chitala lopis* (Bleeker, 1851)	LC	2	35	2	6	UT019
	Notopterus notopterus (Pallas, 1769)	LC	18	2	4	4	LP142
Perciformes							
Anabantidae	*Anabas testudineus* (Bloch, 1792)	DD		5	1		LP115
Channidae	*Channa lucius* (Cuvier, 1831)	LC			1		NV
	Channa micropeltes (Cuvier, 1831)	LC	15	4		5	UT014
	Channa striata (Bloch, 1793)	LC	3	7	1		NV
Cichlidae	**Oreochromis* sp.	NA		1			NV
Eleotrididae	*Oxyeleotris marmorata* (Bleeker, 1852)	LC	25	30			LP145
Gobiidae	*Glossogobius aureus* Akihito & Meguro, 1975	LC		9			LP060
Helostomatidae	*Helostoma temmincki* Cuvier, 1829	LC	5	4			LP144
Osphronemidae	*Osphronemus goramy* La Cepède, 1801	LC	22	8	5	5	LP120
	**Trichopodus pectoralis* Regan, 1910	LC		5			LP141
	Trichopodus trichopterus (Pallas, 1770)	LC		1	6		LP113
Pristolepididae	*Pristolepis fasciata* (Bleeker, 1851)	LC		43		2	LP116
Pleuronectiformes							
Soleidae	*Brachirus panoides* (Bleeker, 1851)	LC		1	1		KM005
Siluriformes							
Bagridae	*Bagrichthys macracanthus* (Bleeker, 1854)	NA		5	2		LP097
	Hemibagrus nemurus (Valenciennes, 1840)	LC	26	23	21	49	LP003
	Hemibagrus planiceps (Valenciennes, 1840)	NA		9			LP138
	Hemibagrus wyckii (Bleeker, 1858)	LC	5	1	3	5	UT030
	Mystus nigriceps (Valenciennes, 1840)	NA		20	9	4	LP048
Clariidae	*Clarias leiacanthus* Bleeker, 1851	NA		34			LP114
Loricariidae	**Hypostomus plecostomus* (Linnaeus, 1758)	NA			1		NV
Pangasiidae	*Helicophagus waandersii* Bleeker, 1858	NA	4	19	5		KM001
	**Pangasius bocourti* Sauvage, 1880	LC	19				NV
	**Pangasianodon hypophthalmus* Sauvage, 1878	EN	18	51	8		KM011
	Pangasius nasutus Bleeker, 1863	LC	25	35	10	8	LP041
	Pseudolais micronemus (Bleeker, 1846)	DD	18	46	33	160	LP104
Schilbeidae	*Laides hexanema* (Bleeker, 1852)	NA		125	23	8	LP035
Siluridae	*Belodontichthys dinema* (Bleeker, 1851)	NA	18	16	4	6	UT009
	Ceratoglanis scleronema (Bleeker, 1863)	NA	4	14			LP011
	Kryptopterus limpok (Bleeker, 1852)	NA			7		NV
	Phalacronotus apogon (Bleeker, 1851)	LC	4	51	86	27	NV
	Wallago leerii Bleeker, 1851	NA	24	2	2		NV
Sisoridae	*Bagarius yarrelli* (Sykes, 1839)	NT	14	6	18	7	LP126
Synbranchiformes							
Mastacembelidae	*Macrognathus keithi* (Herre, 1940)	NA		2	1	4	LP127
	Mastacembelus erythrotaenia Bleeker, 1850	LC		1		1	LP166
	Mastacembelus favus Hora, 1923	LC		5	2	1	NV
	Mastacembelus unicolor Valenciennes, 1832	NA			1		UT005
TETRAODONTIFORMES							
Tetraodontidae	*Auriglobus modestus* (Bleeker, 1850)	LC		1			LP040
Total (orders) = 10 **Total (genera) = 64** **Total (family) = 25**	**Total number of species = 82** **Total number of collected fish = 4834**		**28** **368**	**64** **2075**	**55** **796**	**47** **1595**	
**Shannon-Weiver Diversity Index (1963)			NA	2.50	2.67	2.40	
**Pielou's Evenness Index (1969)			NA	0.79	0.88	0.78	
**Margalef's Richness Index (1958)			NA	4.70	4.81	4.26	

[1] LC: Least concern; NA: Not assessed; EN: Endangered: DD: Data deficient; NT: Near-threatened
[2] Study sites: P: Pekan; M: Maran; T: Temerloh; J: Jerantut
[2] Vouchers: UT: Ulu Tembeling; LP: Lubuk Paku; NV: No voucher; KM: Kuala Mai

The lowest total number of fish species was recorded in Pekan District. Considerable lower number of fish collected in Pekan District was expected, due to non-random fish sampling in this site. The fishermen in this local market were also selective as they only captured fish for consumption purposes and ignored species of fish that do not have economic value. The number of species present at each site fluctuated from Pekan to Jerantut districts, showing no significant pattern. The fluctuation and also species replacement can thus be concluded to reflect the orientation of the River Continuum Concept (Vannote et al. 1980). Several factors such as gradient changes of water quality, habitat heterogeneity, water velocity and riverbed substrates may contribute to the fluctuation and species replacement (Hashim et al. 2012a). Moreover, our results showed that the indexes used did not show much difference in terms of diversity, evenness, and richness between the study sites. According to Zakaria-Ismail (1992) this indexes indicate that the fishes were well distributed, common and abundant in both analyzed rivers, and are less influenced by temporal and seasonal variation factors.

Cyprinidae presented the highest fish species number, followed by Bagridae, Pangasiidae and Siluridae, in the Tembeling and Pahang rivers. The highest number of cyprinid species was widely observed throughout several main rivers in this country for both Peninsular and East Malaysia (Zakaria-Ismail 1994; Parenti and Lim 2005; Azham and Harinder 2011; Hashim et al. 2012a, 2012b). Findings from the present study is supported by Chong et al. (2010), which documented from a total of 1,951 species of freshwater and marine fishes in Malaysia, the five most families with over 50 species each were Cyprinidae (150), Gobiidae (131), Pomacentridae (108), Labridae (85), and Serranidae (68).

A total of 24 common introduced freshwater fish species have been reported in Malaysia (Chong et al. 2010). These species have been introduced for the purpose of aquaculture, aquarium trade, and game fishing. Most of introduced fish species captured in this study, however, were not considered invasive, and mainly introduced for the purposes of aquaculture, such as *P. bocourti, P. hypophthalmus*, *B. gonionotus*, *C. idella, H. nobilis*, and *L. rohita*, while as ornamental fish for *T. pectoralis* and *H. plecostomus*. However, only *Oreochromis* sp., which was initially introduced for aquaculture, could be considered invasive, where their numbers grow rapidly and often displacing native species particularly in lakes, ponds, and even in some estuaries (Chong et al. 2010). Previous studies explained that introduced fish species were able to establish themselves in the local habitats in Malaysia, which may be explained by their occurrence in our present study (Azmir and Samad 2010; Shah et al. 2010; Khairul-Adha et al. 2013; Zulkafli et al. 2014a). The compositions of invasive fishes in these rivers were still considered low (0.03% of total collected fish), however, this aspect should not be ignored by the responsible authorities in the future.

Three endangered fish species, including *B. melanopterus*, *P. jullieni* and *H. signifer* inhabit the rivers, which indicate the importance of these river ecosystems in their survival (Zulkafli et al. 2014b). However, only a small number of these fishes have been collected, especially for *H. signifer*, which reflects its current endangered status. Moreover, most of the endangered species were captured in Maran, Temerloh and Jerantut districts, where the sites were characterized by a large river with deep slow reaches, a river bed that is usually covered with sand or gravel substrates, and no tidal influence, as seen in Pekan District. *Pangasianodon hypophthalmus* captured in this study is not supposed to be native. We believed that they escaped from the floating net cage farms in the Pahang River, as they are imported and intensively cultured for aquaculture purposes in this state (Siti-Zahrah et al. 2014; Zulkafli et al. 2014a).

These updated and comprehensive fish checklist could provide important information to the current knowledge of fish that inhabit along the Tembeling and Pahang rivers, Malaysia. Moreover, these findings also might be beneficial for future planning on fisheries activities and fish conservation of the rivers in the future.

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